# Deep Space Network
# SPC–40 Depot Level Maintenance Feasibility Study

February 13, 2006

David G. Morris

***NASA / Jet Propulsion Laboratory***

# Purpose

- The purpose of this study is to determine the impact to users of the DSN from the implementation of the Depot Level Maintenance Plan (DLM). DLM is a plan devised by DSMS to improve reliability and ensure proper maintenance and care of DSN antennas.
- Specifics:
  - Forecast DSN mission support while a single Canberra antenna is unavailable during a one-month downtime selected between September 2007 and April 2008.
  - Can other DSN resources accommodate loading of a down antenna during a one month period of a planned Depot Level Maintenance?
  - Can we forecast that the DSN will achieve at least 80% supportability for mission requirements?

# Resource Allocation Planning Service (RAPS)



## Assumptions

- Only one month is selected for analysis. Then three separate downtime cases (70M, 34H, 34B) are evaluated.
- Mission Set From February 2006 Resource Allocation Review with the following modifications:
  - IMAGE requirements deleted from Mission set
  - Planned launches occurring as scheduled
- DSN Assets
  - Only the antenna in the analysis case is down during the one month period
  - 26 Meter Subnet is not included in the DLM plan, but is available for support
  - 200W S-band uplink at DSS-45 and DSS-65 are implemented and operational

# Analyses

## DSS-43 and the 70 Meter Subnet

- Oversubscription at all 70 Meter antennas exist in this period, but is at a workable level. Removing the DSS-43 antenna from service causes overloading not only at DSS-14 and DSS-63 but increases contention at all other subnets specifically at DSS-34.
- 70 Meter contention exists due to requirements supporting Cassini, MARS missions and Relay requirements, MESSENGER Deep Space maneuver (DSM) and NHPC Checkout

## DSS-45 and the 34HEF Subnet

- There is little to no oversubscription at the 34HEF antennas. The oversubscription only occurs at DSS-45 and is typically due to more requirements for Southern hemisphere view, but is at a workable level.
- Removing the DSS-45 antenna from service causes overloading specifically at DSS-34 and 43. Although some offloading is absorbed at DSS-15 and DSS-65 there are specific supports that require Southern hemisphere tracking. It is necessary to offload these requirements to DSS-34 and 43.

## DSS-34 and the 34BWG1 Subnet

- High contention exists at DSS-34 due to heavy requirements for Southern hemisphere tracking, S-band uplink and Ka Band downlink requirements.
- Removing DSS-34 from service causes increased contention at DSS-43 and DSS-45. Although DSS-45 can absorb some requirements there still exist some requirements for Ka-Band that cannot be supported.

# Resource Allocation Planning Service (RAPS)



## Summary of Results:

- October 2007 selected because of moderate amount of User requirements, no scheduled launches, and Spring in Canberra.
- Higher contention exists when taking DSS-43 down. Goldstone and Madrid cannot satisfy all 70M demand.
- DLM in October for DSS-45 produces the least impact of the three cases to the network and Users.
- There exists high contention at the DSS-34 antenna, but a majority of requirements can be absorbed by the DSN with some exceptions.

Remember:

- In order to properly prepare for a DLM downtime, a minimum of 6 to 8 month lead time is required to coordinate with the Missions in order to prevent rework and renegotiation.
- To plan the best fit and minimize project impact for DLM downtime, additional studies should be performed.

The Results Of This Study Are Subject To Change, In That Network Loading Changes, As Requirements For Planned Missions Are Input And Updated And Periods Of Antenna Downtime Are Identified.

# Backup Material

# Resource Allocation Planning Service (RAPS)

Jet Propulsion Laboratory
California Institute of Technology

## DSS-43 DLM in October 2007 Overall Impact to All Subnets

| | | Overall Supportabillity | | | | | Decrease in Supportabillity | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Missions Impacted** | **Subnet** | **40** | **41** | **42** | **43** | **44** | **40** | **41** | **42** | **43** | **44** |
| ATOT | 70M | 79% | 89% | 88% | 81% | 92% | 12% | 7% | 6% | 8% | 6% |
| GBRA | All | 74% | 88% | 88% | 85% | 92% | 9% | 8% | 5% | 7% | 3% |
| GSSR | All | 100% | 85% | 81% | 97% | 86% | 0% | 11% | 14% | 3% | 9% |
| M01O | All | 66% | 86% | 83% | 81% | 97% | 20% | 8% | 10% | 9% | 2% |
| MEX | All | 82% | 99% | 98% | 97% | 99% | 10% | 0% | 1% | 0% | 0% |
| MGS | All | 85% | 75% | 76% | 73% | 82% | 0% | 4% | 4% | 5% | 5% |
| MSGR | All | 92% | 90% | 90% | 82% | 96% | 2% | 0% | 0% | 8% | 0% |
| NHPC | 70M | 87% | 91% | 88% | 85% | 92% | 7% | 5% | 6% | 7% | 5% |
| STF | 70M | 88% | 87% | 85% | 82% | 88% | 5% | 9% | 10% | 11% | 9% |
| ULYS | All | 86% | 83% | 82% | 81% | 84% | 11% | 10% | 10% | 10% | 8% |
| WMAP | 70M | 93% | 100% | 100% | 97% | 99% | 7% | 0% | 0% | 3% | 1% |

Analysis indicates that if DSS-43 is taken down for DLM in October 2007, that most users supportabillity will decrease from 5% to 20% as illustrated to the left.

## DSS-43 DLM in October 2007 Overall Impact to the 70M Subnet Only

| | | Overall Supportabillity | | | | | Decrease in Supportabillity | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Missions Impacted** | **Subnet** | **40** | **41** | **42** | **43** | **44** | **40** | **41** | **42** | **43** | **44** |
| ATOT Development | 70M | 79% | 89% | 88% | 81% | 92% | 6% | -5% | -6% | -1% | -8% |
| CAS Tour | 70M | 92% | 89% | 83% | 91% | 91% | 3% | 5% | 5% | 5% | 6% |
| CLU2 1/2/3/4 SSO | 70M | 94% | 99% | 99% | 97% | 99% | 5% | 1% | 1% | 2% | 1% |
| DSS | 70M | 62% | 76% | 66% | 58% | 75% | 9% | -3% | 6% | 8% | 6% |
| GBRA | 70M | 74% | 88% | 86% | 85% | 92% | 13% | 8% | 7% | 7% | 5% |
| GSSR | 70M | 100% | 78% | 64% | 97% | 79% | 0% | 17% | 27% | 3% | 18% |
| M01O | 70M | 66% | 86% | 83% | 81% | 97% | 20% | 8% | 10% | 9% | 2% |
| MEX R/S Bi Static | 70M | 82% | 100% | 88% | 100% | 96% | 10% | 0% | 9% | 0% | 3% |
| MSGR DSM-2 | 70M | 100% | 100% | 100% | 55% | 100% | 0% | 0% | 0% | 33% | 0% |
| NHPC Checkout | 70M | 87% | 91% | 88% | 85% | 92% | 7% | 5% | 6% | 7% | 5% |
| STF | 70M | 88% | 87% | 85% | 82% | 88% | 5% | 9% | 10% | 11% | 9% |
| ULYS Nutation | 70M | 67% | 70% | 70% | 67% | 74% | 24% | 28% | 27% | 25% | 23% |
| VGR1 | 70M | 100% | 100% | 100% | 71% | 87% | 0% | 0% | 0% | 16% | 13% |
| WMAP | 70M | 93% | 100% | 100% | 97% | 99% | 7% | 0% | 0% | 3% | 1% |

Analysis indicates that if DSS-43 is taken down for DLM in October 2007, that most 70M users supportabillity will decrease from 5% to 20% as illustrated to the left.

There are however some supports that were deleted as in all study cases that require specific support at DSS-43, such as CLU2 and GBRA Host Country.

# Resource Allocation Planning Service (RAPS)

Jet Propulsion Laboratory
California Institute of Technology

## DSS-45 DLM in October 2007 Overall Impact to All Subnets

| | | Overall Supportabillity | | | | | Decrease in Supportabillity | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Missions Impacted** | **Subnet** | **40** | **41** | **42** | **43** | **44** | **40** | **41** | **42** | **43** | **44** |
| CAS | All | 93% | 95% | 93% | 96% | 97% | 5% | 2% | 2% | 1% | 1% |
| DSN | All | 95% | 90% | 98% | 92% | 89% | 0% | 3% | 0% | 0% | 6% |
| GBRA | All | 81% | 95% | 94% | 92% | 96% | 2% | 0% | 0% | 0% | 0% |
| GSSR | All | 100% | 91% | 94% | 100% | 90% | 0% | 4% | 1% | 0% | 5% |
| MEX | All | 92% | 93% | 98% | 97% | 93% | 0% | 5% | 0% | 0% | 6% |
| MRO | All | 91% | 95% | 96% | 97% | 98% | 6% | 3% | 2% | 1% | 2% |
| MSGR | All | 83% | 85% | 86% | 86% | 88% | 11% | 5% | 4% | 3% | 8% |
| PHX | All | 86% | 100% | 100% | 100% | 100% | 5% | 0% | 0% | 0% | 0% |
| STA. | All | 88% | 93% | 93% | 94% | 95% | 2% | 5% | 5% | 3% | 4% |
| ULYS | All | 95% | 88% | 88% | 87% | 86% | 2% | 5% | 5% | 4% | 6% |
| VGR2 | All | 79% | 83% | 85% | 86% | 81% | 10% | 9% | 9% | 8% | 13% |
| WIND | 34B1 | 74% | 69% | 69% | 69% | 68% | 3% | 6% | 7% | 7% | 14% |

Analysis Indicates that supportabillity decreases minimally across the network with DSS-45 down for DLM. Requirements at the 34HEF are at a workable level and most offloading can be accomodated at either DSS-15 and DSS-65 or other antennas at Goldstone and Madrid, but due to existing high contention at DSS-43 and DSS-34 minimal amounts of support were moved there.

There are however some supports that were deleted as in all study cases that require specific support at DSS-45, such as CLU2, GBRA Host Country and SGP.

## DSS-45 DLM in October 2007 Overall Impact to the 34HEF Subnet Only

| | | Overall Supportabillity | | | | | Decrease in Supportabillity | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Missions Impacted** | **Subnet** | **40** | **41** | **42** | **43** | **44** | **40** | **41** | **42** | **43** | **44** |
| MEX Orbital Sci | 34H | 100% | 88% | 99% | 98% | 86% | 0% | 10% | 0% | 1% | 14% |
| GSSR GODR | 34H | 100% | 86% | 97% | 100% | 84% | 0% | 12% | 1% | 0% | 10% |
| RFC | 34H | 100% | 96% | 100% | 99% | 91% | 0% | 4% | 0% | 0% | 5% |

Analysis Indicates that overall supportabillity at the 34HEF subnet is at a workable level due to the minimal requirements in this timeframe and offloading across several subnets.

# Resource Allocation Planning Service (RAPS)

Jet Propulsion Laboratory
California Institute of Technology

## DSS-34 DLM in October 2007 Overall Impact to All Subnets

| | | Overall Supportabillity | | | | | Decrease in Supportabillity | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Missions Impacted** | **Subnet** | **40** | **41** | **42** | **43** | **44** | **40** | **41** | **42** | **43** | **44** |
| ACE | All | 73% | 72% | 70% | 66% | 66% | 0% | 12% | 13% | 12% | 10% |
| ATOT | 70M | 87% | 94% | 93% | 88% | 96% | 5% | 1% | 1% | 2% | 1% |
| DAWN | 34H | 92% | 92% | 93% | 94% | 92% | 4% | 5% | 5% | 3% | 4% |
| M01O | 70M | 77% | 91% | 90% | 87% | 98% | 9% | 3% | 3% | 3% | 0% |
| MER1 | All | 83% | 80% | 81% | 82% | 90% | 6% | 5% | 6% | 7% | 3% |
| MER2 | All | 78% | 78% | 79% | 79% | 88% | 9% | 4% | 8% | 6% | 3% |
| MEX | All | 87% | 99% | 98% | 98% | 97% | 5% | 0% | 0% | 0% | 2% |
| MSGR | All | 92% | 83% | 84% | 85% | 90% | 2% | 7% | 6% | 5% | 6% |
| RFC | 34H | 100% | 98% | 100% | 99% | 91% | -13% | 1% | 0% | 0% | 5% |
| SGP | 34H | 87% | 69% | 100% | 100% | 100% | 9% | 25% | 0% | 0% | 0% |
| ULYS | All | 88% | 92% | 90% | 86% | 92% | 9% | 1% | 2% | 4% | 0% |
| VGR2 | All | 84% | 85% | 88% | 88% | 89% | 5% | 7% | 5% | 5% | 5% |
| WMAP | 70M | 93% | 100% | 100% | 98% | 100% | 7% | 0% | 0% | 2% | 0% |

Analysis indicates that supportabillity for most users over the whole network is decreased due to offloading at DSS-34, specifically DSS-43 and DSS-45.

In some cases users that require Southern Hemisphere tracking would be unable to fulfill requirements due to overloading at DSS-43 and DSS-45. Specifically MRO Ka Ops DEMO, MESSENGER, Stereo A & B, RFC X/Ka Cat M&E, Ulysses and Voyager 2.

## DSS-34 DLM in October 2007 Overall Impact to the 34BWG1 Subnet Only

| | | Overall Supportabillity | | | | | Decrease in Supportabillity | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Missions Impacted** | **Subnet** | **40** | **41** | **42** | **43** | **44** | **40** | **41** | **42** | **43** | **44** |
| CAS Tour | 34B1 | 97% | 98% | 98% | 98% | 99% | -1% | 0% | 0% | 0% | 0% |
| CHDR | 34B1 | 98% | 98% | 96% | 97% | 97% | -1% | -1% | -1% | -2% | 0% |
| CLU2 1/2/3/4 SSO | 34B1 | 100% | 100% | 98% | 98% | 100% | -15% | -5% | -2% | -2% | 0% |
| CLU4 1/2/3/4 MSO | 34B1 | 100% | 100% | 100% | 98% | 100% | -10% | 0% | 0% | -2% | 0% |
| DSN ANTCAL S/X | 34B1 | 100% | 100% | 100% | 98% | 100% | 0% | -15% | 0% | -2% | -9% |
| DSS Maintenance | 34B1 | 76% | 76% | 74% | 71% | 76% | -3% | -2% | -2% | -3% | -2% |
| INTG | 34B1 | 98% | 97% | 97% | 97% | 98% | 0% | -2% | -2% | -4% | -4% |
| MGS Map/Beta Sup | 34B1 | 100% | 95% | 94% | 92% | 97% | 0% | -18% | -15% | -16% | -15% |
| MRO Prime Science | 34B1 | 100% | 98% | 98% | 98% | 99% | -22% | 0% | 0% | 0% | 0% |
| MSGR Cruise | 34B1 | 100% | 95% | 95% | 95% | 100% | 0% | -4% | -5% | -6% | 0% |
| PHX | 34B1 | 98% | 100% | 100% | 100% | 100% | -19% | 0% | 0% | 0% | 0% |
| ROSE Earth Swingby | 34B1 | 100% | 100% | 100% | 100% | 100% | 0% | 0% | 0% | 0% | 0% |
| STA. Prime Science | 34B1 | 98% | 98% | 98% | 98% | 99% | -12% | 0% | 0% | 0% | -1% |
| STB Prime Science | 34B1 | 100% | 100% | 100% | 100% | 100% | -2% | 0% | 0% | 0% | 0% |
| ULYS | 34B1 | 97% | 95% | 94% | 94% | 94% | 1% | -4% | -4% | -3% | -4% |
| WIND | 34B1 | 85% | 88% | 86% | 84% | 90% | -7% | -12% | -9% | -8% | -8% |

Analysis Indicates that overall supportabillity at the 34BWG1 subnet improves because of the averaging of DSS-34 lost time across all 34 BWG1 antennas. However DSS-45 and DSS-43 show a marked decrease in supportabillity due to offloading from DSS-34.

There are however some supports that were deleted as in all study cases that require specific support at DSS-34, such as CLU2 and RFC X/Ka.